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Comparative performance evaluation of TiO_2, and MWCNTs nano-lubricant effects on surface roughness of AA8112 alloy during end-milling machining for sustainable manufacturing process

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Abstract

Aluminium 8112 alloy has become a leading material in the aluminium family and currently used in the aerospace and automobile industries due to its excellent chemical and mechanical properties. However, during machining of aluminium alloy, one of the challenges faced by the manufacturing industry is the material adhesion, which increases the rate of chips discontinuity at the machining region and leads to a high surface roughness of the workpiece. The focus of this research is to proffer solutions to this material adhesion by implementing vegetable oil that is copra oil-lubricant, titanium dioxide (TiO_2) and multi-walled carbon nanotube (MWCNTs) nano-lubricants during end-milling of AA8112 alloy. Also, using quadratic rotatable central composite design (QRCCD) to study the effects of the machining parameters under

minimum quantity lubrication condition, this research used the two-step method to synthesise the nano-lubricants and carried out the homogenisation using the magnetic stirrer and ultrasonic cleaner machine. The study considered five machining factors, including spindle speed, feed rate, length of cut, depth of cut and helix angle. The result from the surface roughness shows that the TiO_2 nano-lubricant reduces the surface roughness with 10% and 17% when compared with the MWCNTs nano-lubricant and copra oil. The minimum surface roughness of 1.15 µm, 1.16 µm and 1.35 µm, for the three machining environments, was achieved, respectively. Spindle speed is the most influential machining parameter, followed by the feed rate. The result of this study will aid the manufacturing industry to produce an excellent quality product for a cleaner manufacturing system.

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